PROJECT facts

Sequestration

03/2004

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

CO_2 Hydrate Process for Gas Separation from a Shifted Synthesis Gas Stream

Background

One approach to decarbonizing coal is to gasify it to form fuel gas consisting predominately of carbon monoxide and hydrogen. This fuel gas is sent to a shift conversion reactor where carbon monoxide reacts with steam to pro-duce carbon dioxide and hydrogen. After scrubbing the carbon dioxide from the fuel, an almost pure hydrogen stream is left which can be burned in a gas turbine or used to power a fuel cell with essentially zero emissions. However, for this approach to be practical, it will require an economical means of separating carbon dioxide from mixed gas streams. Since viable options for sequestration or reuse of carbon dioxide are projected to involve transport through pipelines and/or direct injection of high pressure carbon dioxide into various repositories, a process that can separate carbon dioxide at high pressures and minimize recompression costs will offer distinct advantages. This project addresses the issue of carbon dioxide separation from shifted synthesis gas at elevated pressures.

The project is concerned with development of the low temperature SIMTECHE process. This process utilizes the formation of carbon dioxide hydrates to remove CO_2 from a gas stream. Many people are familiar with methane hydrates but are unaware that, under the proper conditions, CO_2 forms similar hydrates. In Phase 1, a conceptual process flow scheme was developed. The thermodynamic limits of such a process were confirmed by equilibrium hydrate formation experiments for shifted synthesis gas com-positions. Performance projections were then made for a few selected process configurations, and encouraging preliminary economics were developed.

Primary Project Goal

The goal of this project is to construct and operate a pilot-scale unit utilizing the hydrate process for CO_2 separation.

Objectives

The program is currently in phase 2 of a 3-phase plan. The objectives of phase 2 are: (1) carry out further laboratory-scale tests of the CO_2 hydrate concept, including extended continuous-flow tests and component tests; (2) conduct an engineering analysis of the concept, and develop updated estimates of the process performance and cost of carbon control; (3) use data developed in the lab to design and build a pilot plant using a slipstream in an operating IGCC plant. Phase 3 will consist of a pilot demonstration of the process in the IGCC plant.

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PROJECT PARTNERS

Nexant
Los Alamos National Laboratory (LANL)
SIMTECHE

COST

Total Project Value:
$15,993,621

Nexant
DOE Share: $9,076,621
Non-DOE Share: $0

Los Alamos National Laboratory
DOE: $6,917,000
Non-DOE Share: $0

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

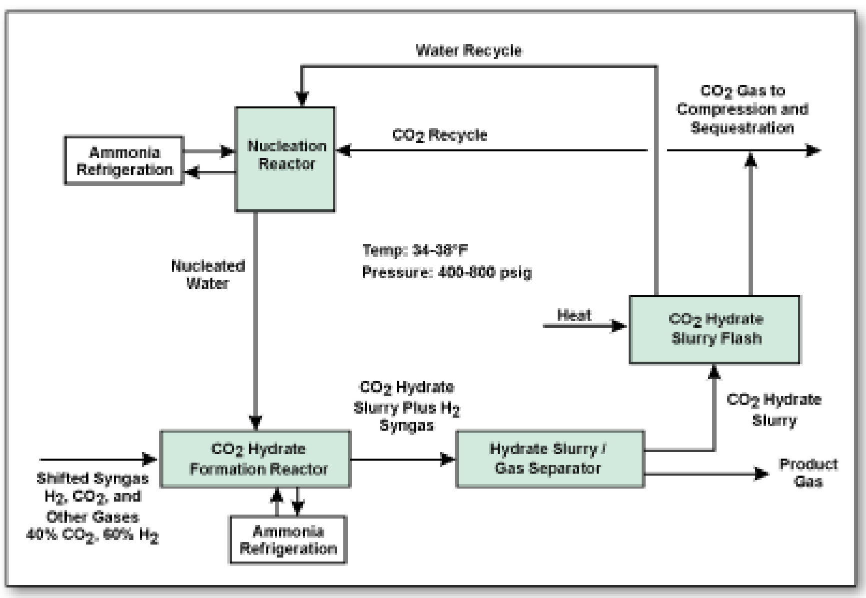
Accomplishments

A bench-scale flow system for the continuous production of carbon dioxide hydrates was assembled, and operational issues associated with continuous hydrate production were resolved. The technical feasibility of the SIMTECHE process was thereby demonstrated. The enhancement of carbon dioxide hydrate formation and separation by the presence of gaseous and/or liquid promoters was also demonstrated in the laboratory.

Benefits

The hydrate process will provide a high pressure/low temperature system for separating CO_2 from shifted synthesis gas in an economical manner. The process can be adapted to an existing gasification power plant for CO_2 separation in the production of synthesis gas.

Overall, the process will result in a residual concentrated stream of hydrogen capable of fueling zero-emission power plants of the future and a concentrated CO_2 stream available for use or sequestration.



Conceptual Process Block Flow Diagram of a CO_2 Hydrate Process